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European Patent Office  
Office européen des brevets



(11) EP 0 840 180 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:  
06.05.1998 Bulletin 1998/19

(51) Int Cl.<sup>6</sup>: G03G 15/20

(21) Application number: 97308833.9

(22) Date of filing: 04.11.1997

(84) Designated Contracting States:  
AT BE CH DE DK ES FI FR GB GR IE IT LI LU MC  
NL PT SE

(30) Priority: 05.11.1996 US 744031

(71) Applicant: XEROX CORPORATION  
Rochester, New York 14644 (US)

(72) Inventors:  
• Badesha, Santokh, S.  
Pittsford, NY 14534 (US)  
• Pan, David H.  
Rochester, NY 14625 (US)  
• Kaplan, Samuel  
Walworth, NY 14568 (US)  
• Eddy, Clifford O.  
Penfield NY 14580 (US)

- Henry, Arnold W.  
Pittsford, NY 14534 (US)
- Heeks, George J.  
Rochester, NY 14617 (US)
- Chow, Che C.  
Penfield, NY 14526 (US)
- Fratangelo, Louis D.  
Fairport, NY 14450 (US)
- Fraser, David J.J.  
Webster, NY 14580 (US)
- Hanzlik, Edward C.  
Fairport, NY 14450 (US)

(74) Representative: Pike, Christopher Gerard et al  
Rank Xerox Ltd.,  
Patent Department,  
Parkway  
Marlow, Buckinghamshire SL7 1YL (GB)

(54) Coated fuser member

(57) A fuser member having a fuser member release agent for use in an electrophotographic apparatus for enhancing toner release from a fuser member, the fuser

member comprising a substrate (4), an outer fluoropolymer layer (2) optionally comprising a conductive filler, and a silicone hydride release oil component thereover.

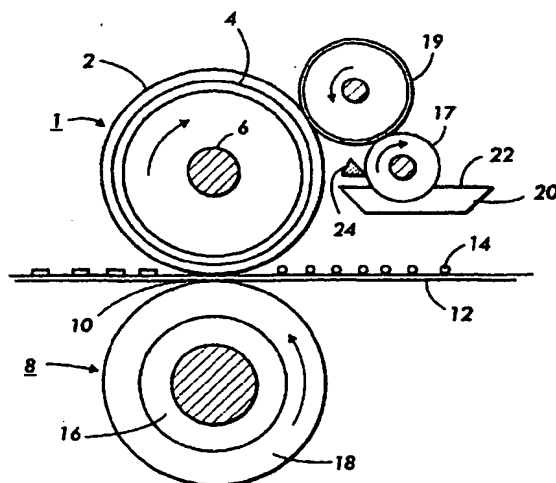


FIG. 1

## Description

The present invention relates to fusing members and, more specifically, the present invention relates to fuser member coatings comprising functional release agents that, for example, enhance release of toner from a fuser roll in an electrostatographic, especially xerographic, machine. In embodiments, the release agents of the present invention are comprised of a hydride (SiH) functional silicone oil that prevents offset by providing a coating on a fuser roll substrate, which preferably has an outer layer of a high temperature resistant polymer and in embodiments, a fluoropolymer. In embodiments, the coating reacts with a conductive filler which is present on the polymer surface layer of the fuser roll. Advantages of the fuser members of the present invention include, in embodiments, reduction in toner offset, providing lower surface energy of the outer fusing layers, providing a more uniform coating of fusing oil on the fusing surface layer, decreasing the amount of wax needed in toners, increasing fuser release life, and rapid diffusion of the fuser oil into the copy sheet, thereby reducing or alleviating the problems of poor fix of certain inks such as magnetic inks and reducing or eliminating poor adhesion of binding glues and attachable notes such as 3-M Post-It® notes. In embodiments, the release coatings of the present invention can be obtained by combining a hydride functional siloxane with active functional groups on filler components thereby providing a low surface energy silicone surface over the filler. The fuser members of the present invention including the fuser oils herein, which can be selected for a number of known electrophotographic imaging and printing processes, possess a number of advantages as indicated herein.

Several approaches to thermal fusing of electroscopic toner images have been described. These methods include providing the application of heat and pressure substantially concurrently by various means, a roll pair maintained in pressure contact, a belt member in pressure contact with a roll, and a belt member in pressure contact with a heater. Heat may be applied by heating one or both of the rolls, plate members, or belt members. The fusing of the toner particles takes place when the proper combination of heat, pressure and contact time are provided.

During operation of a fusing system in which heat is applied to cause thermal fusing of the toner particles onto a support, both the toner image and the support are passed through a nip formed between the roll pair, or plate or belt members. The concurrent transfer of heat and the application of pressure in the nip affects the fusing of the toner image onto the support. It is important in the fusing process that no offset of the toner particles from the support to the fuser member take place during normal operations. Toner particles offset onto the fuser member may subsequently transfer to other parts of the machine or onto the support in subsequent copying cycles, thus increasing the background or interfering with the material being copied there. The referred to "hot offset" occurs when the temperature of the toner is increased to a point where the toner particles liquefy and a splitting of the molten toner takes place during the fusing operation with a portion remaining on the fuser member. The hot offset temperature or degradation of the hot offset temperature is a measure of the release property of the fuser roll, and accordingly it is desired to provide a fusing surface which has a low surface energy to provide the necessary release. To ensure and maintain good release properties of the fuser roll, it has become customary to apply release agents to the fuser roll during the fusing operation. Typically, these materials are applied as thin films of, for example, silicone oils or amino oils, to prevent toner offset.

One drawback to the use of monoamino silicone and silicone fuser release agents is that the release agents do not always react as well with conductive fillers which may be present in the fuser roll surface. It is desirable for the release agent to react with the fillers present on the outer surface of the fuser member in order to lower the surface area of the fillers. The result is that the conductive filler may be highly exposed on the surface of the fuser member, thereby resulting in increased surface energy of the exposed conductive filler which will cause toner to adhere to it. An increased surface energy, in turn, results in decrease in release, increase in toner offset, and shorter fusing release life.

Therefore, there exists a specific need for a fusing member release agent for use with a polymer, and more specifically a fluoropolymer, outer layer of a fuser member, wherein the release agent does not remain on the surface of the copy sheet. In addition, a specific need exists for a release agent useful in connection with conductive particle filled fluoropolymer outer surfaces of fuser members, wherein the release agent sufficiently reacts with the conductive filler on the outer surface of the fuser member, enabling a reduction in surface energy of the exposed conductive filler, which ultimately results in a decrease in toner offset and longer fuser release life. Moreover, a need exists for a fusing member release agent for use with a polymer outer layer of a fuser member, wherein the release agent which can be used in relatively small amounts and wherein the release agent does not require a relatively large amount of wax to be incorporated into the toner in order to be effective.

According to one aspect of the present invention there is provided a fuser member comprising: a) a substrate; b) an outer layer on the substrate, the outer layer comprising a polymer and thereover c) a hydride release component comprising a silicone hydride release oil.

In a preferred aspect, the outer layer comprises polyfluoroalkoxypolytetrafluoroethylene and contains an inorganic particulate filler selected from the group consisting of aluminum oxide and cupric oxide, wherein the filler is present on the surface of the outer layer. Preferably, the hydride release component comprises a poly(methylhydrosiloxane) film that reacts with the surface filler particles so as to lower the surface energy of the filler particles.

In another preferred aspect, the outer layer comprises a fluoroelastomer selected from the group consisting of i) copolymers of vinylidene fluoride and hexafluoropropylene; ii) terpolymers of vinylidene fluoride, hexafluoropropylene and tetrafluoroethylene; and iii) tetrapolymers of vinylidene fluoride, hexafluoropropylene, tetrafluoroethylene and a cure site monomer, wherein the outer layer preferably also contains a calcined alumina particulate filler dispersed therein and present on the surface of the fluoroelastomer outer layer.

According to another aspect of the present invention there is provided an image forming apparatus for forming images on a recording medium comprising: a) a charge-retentive surface to receive an electrostatic latent image thereon; b) a development component to apply toner to the charge-retentive surface to develop the electrostatic latent image to form a developed image on the charge retentive surface; c) a transfer component to transfer the developed image from the charge retentive surface to a copy substrate; and d) a fixing component for fusing toner images to a surface of the copy substrate, wherein the fixing component comprises a fuser member as described above.

According to a further aspect of the present invention there is provided an electrophotographic process comprising: a) forming an electrostatic latent image on charge-retentive surface; b) applying toner to the latent image to form a developed image on the charge retentive surface; c) transferring the toner image from the charge-retentive surface to a copy substrate; d) fixing the toner image to the copy substrate by passing the copy substrate containing the toner image in between a pressure member and a fixing member as described above.

The fuser member release agents provided herein, the embodiments of which are further described herein, allow for a decrease in the amount of fuser oil necessary for toner release, enable reduction in surface energy of the conductive fillers present on the surface of the fuser member while allowing for sufficient fix of inks, adhesives and glues to the surface of copy sheets.

For a better understanding of the present invention, reference may be had to the accompanying Figure:

Figure 1 illustrates a fusing system in accordance with an embodiment of the present invention.

The present invention is directed to fuser members for use in electrostatographic machines, and more specifically, fuser members comprising a support, and having thereon an outer layer. In embodiments, the outer layer comprises a polymer such as a fluoropolymer and, in particular embodiments, further contains an inorganic particulate filler. In specific embodiments, the fuser members herein comprise a silicone hydride release agent film over the outer polymer surface layer of the fuser member. Also in embodiments, the release agent reacts with the filler present on the outer surface of the fuser member in order to reduce the surface energy of the exposed conductive particulate fillers and increase toner release.

The present process, in embodiments, enables surfaces as described in conjunction with a fuser assembly as shown in Figure 1 where the numeral 1 designates a fuser roll comprising elastomer surface 2 upon a suitable base member 4, a hollow cylinder or core fabricated from any suitable metal, such as aluminum, anodized aluminum, steel, nickel, copper, and the like, having a suitable heating element 6 disposed in the hollow portion thereof which is coextensive with the cylinder. Backup or pressure roll 8 cooperates with fuser roll 1 to form a nip or contact arc 10 through which a copy paper or other substrate 12 passes such that toner images 14 thereon contact elastomer surface 2 of fuser roll 1. As shown in Figure 1, the backup roll 8 has a rigid steel core 16 with a polymer or elastomer surface or layer 18 thereon. Sump 20 contains polymeric release agent 22 which may be a solid or liquid at room temperature, but it is a fluid at operating temperatures.

In the embodiment shown in Figure 1 for applying the polymeric release agent 22 to polymer or elastomer surface 2, two release agent delivery rolls 17 and 19 rotatably mounted in the direction indicated are provided to transport release agent 22 to polymer or elastomer surface 2. Delivery roll 17 is partly immersed in the sump 20 and transports on its surface release agent from the sump to the delivery roll 19. By using a metering blade 24, a layer of polymeric release fluid can be applied initially to delivery roll 19 and subsequently to polymer or elastomer 2 in controlled thickness ranging from submicrometer thickness to thickness of several micrometers of release fluid. Thus, by metering device 24, about 0.1 to 2 micrometers or greater thicknesses of release fluid can be applied to the surface of elastomer 2.

In accordance with the present invention, the substrate for fixing or fusing a thermoplastic resin powder image to a substrate at elevated temperatures may be either a hollow or solid roll, a flat surface, a belt or of any other suitable configuration. However, in accordance with a preferred embodiment of the present invention, the substrate is in the form of a hollow cylindrical roll.

The types of components such as rolls that can be provided with the coatings of the present invention are illustrated, for example, in U.S. Patents 4,373,239 and 4,518,655. The substrate can be constructed entirely of the polymer. However, in preferred embodiments, the substrate is a roll structure comprising a base member made of a hollow cylindrical metal core such as copper, aluminum, steel and the like or coated layers of copper, steel, and aluminum and the like, having a working surface of polymer which, in embodiments, contains an inorganic particulate filler dispersed therein and present on the surface of the polymer. The base member may be any suitable material having a polymer layer adhered thereto, and the design is not limited to any particular metal, non-metal or composite.

The outer or top surface of the fuser member, or the entire composition of the fuser member, in embodiments, is comprised of a polymer, preferably a fluoropolymer. The fluoropolymer must be a heat stable elastomer or resin material

which can withstand elevated temperatures generally from about 90°C up to about 200°C or higher depending upon the temperature desired for fusing or fixing the thermoplastic resin powder to the substrate. The fluoropolymer used in the present invention must react with but not be degraded by the hydride release agents which are used to promote release of the molten or tackified thermoplastic resin powder or toner from the fuser member surface.

5 Examples of the outer surface or intermediate layer of the fuser system members in the present invention include polymers such as fluoropolymers. Specifically, suitable fluoropolymers are those described in detail in U.S. Patents 5,166,031, 5,281,506, 5,366,772 and 5,370,931, together with U.S. Patents 4,257,699, 5,017,432 and 5,061,965. As described therein these fluoropolymers, particularly from the class of copolymers of vinylidenefluoride and hexafluoropropylene; terpolymers of vinylidenefluoride, hexafluoropropylene and tetrafluoroethylene; and tetrapolymers of vinylidenefluoride, hexafluoropropylene, tetrafluoroethylene and cure site monomer, are known commercially under various designations as VITON A®, VITON E®, VITON E 60C®, VITON E430®, VITON 910®, VITON GH® and VITON GF®. The VITON® designation is a Trademark of E.I. DuPont de Nemours, Inc. The cure site monomer can be 4-bromoperfluorobutene-1, 1,1-dihydro-4-bromoperfluorobutene-1, 3-bromoperfluoropropene-1, 1,1-dihydro-3-bromoperfluoropropene-1, or any other suitable, known cure site monomer commercially available from DuPont. Other commercially available fluoropolymers include FLUOREL 2170®, FLUOREL 2174®, FLUOREL 2176®, FLUOREL 2177® and FLUOREL LVS 76®, FLUOREL® being a Trademark of 3M Company. Additional commercially available materials include AFLAS™ a poly(propylene-tetrafluoroethylene) and FLUOREL II® (LI1900) a poly(propylene-tetrafluoroethylene-vinylidenefluoride) both also available from 3M Company, as well as the Tecnoflons identified as FOR-60KIR®, FOR-LHF®, NM® FOR-THF®, FOR-TFS®, TH®, and TN505®, available from Montedison Specialty Chemical Company.

Other fluoropolymers useful in the present invention include polytetrafluoroethylene (PTFE), fluorinated ethylene-propylene copolymer (FEP), and polyfluoroalkoxypolytetrafluoroethylene (PFA Teflon).

These fluoropolymers, together with adhesives, can also be included as intermediate layers.

Preferred fluoropolymers useful for the surface of fuser members in the present invention include fluoroelastomers, such as fluoroelastomers of vinylidenefluoride based fluoroelastomers, which contain hexafluoropropylene and tetrafluoroethylene as comonomers. Three preferred known fluoroelastomers are (1) a class of copolymers of vinylidenefluoride and hexafluoropropylene known commercially as VITON A (2) a class of terpolymers of vinylidenefluoride, hexafluoropropylene and tetrafluoroethylene known commercially as VITON B® and (3) a class of tetrapolymers of vinylidenefluoride, hexafluoropropylene, tetrafluoroethylene and cure site monomer known commercially as VITON GH® or VITON GF®, VITON A®, VITON B®, VITON GH®, VITON GF® and other VITON® designations are trademarks of E.I. DuPont de Nemours and Company.

The fluoroelastomers VITON GH® and VITON GF® available from E.I. DuPont de Nemours Inc., have a preferred embodiment of relatively low amounts of vinylidenefluoride. The VITON GF® and VITON GH® have 35 weight percent of vinylidenefluoride, 34 weight percent of hexafluoropropylene and 29 weight percent of tetrafluoroethylene with 2 weight percent cure site monomer.

In a further preferred embodiment, the fluoropolymer is PFA Teflon, FEP, PTFE, VITON GF® or VITON GH®. In a particularly preferred embodiment, the fluoropolymer is PFA Teflon, VITON GF® or VITON GH®.

The amount of fluoropolymer compound in solution in weight percent total solids is from about 10 to about 25 percent preferably from about 16 to about 22 percent by weight of total solids. Total solids as used herein includes the amount of fluoropolymer, dehydrofluorinating agent and optional adjuvants and fillers, including metal oxide fillers.

Any known solvent suitable for dissolving a fluoropolymer in the preparation of the fluoropolymer surface may be used. Examples of suitable solvents for the present invention include methyl ethyl ketone, methyl isobutyl ketone, diethyl ketone, n-butyl acetate, amyl acetate, and the like. Specifically, the solvent is added in an amount of from about 75 to about 90 weight percent, preferably from about 78 to about 84 weight percent based on the weight of total solids.

The dehydrofluorinating agent which attacks the hydrofluoroelastomer class of fluoropolymers generating unsaturation is selected from basic metal oxides such as MgO, CaO, Ca(OH)<sub>2</sub> and the like, and strong nucleophilic agents such as primary, secondary and tertiary, aliphatic and aromatic amines, where the aliphatic and aromatic amines have from about 2 to about 15 carbon atoms. Also included are aliphatic and aromatic diamines and triamines having from about 2 to about 15 carbon atoms where the aromatic groups may be benzene, toluene, naphthalene, anthracene, and the like. It is generally preferred for the aromatic diamines and triamines that the aromatic group be substituted in the ortho, meta and para positions. Typical substituents include lower alkyl amino groups such as ethylamino, propylamino and butylamino, with propylamino being preferred. The particularly preferred curing agents are the nucleophilic curing agents such as VITON CURATIVE VC-50® which incorporates an accelerator (such as a quaternary phosphonium salt or salts like VC-20) and a crosslinking agent (bisphenol AF or VC-30); DIAK 1 (hexamethylenediamine carbamate) and DIAK 3 (N,N'-dicinnamylidene-1,6 hexanediamine). VC-50 is preferred due to the more thermally stable product it provides. The dehydrofluorinating agent is added in an amount of from about 1 to about 20 parts per hundred of hydrofluoroelastomer, and preferably from about 4 to about 6 parts per hundred of hydrofluoroelastomer.

An inorganic particulate filler may be and is usually used in connection with the fluoropolymer outer layer. The

inorganic particulate filler, in embodiments, increases the abrasion resistance of the outer layer. The inorganic particulate filler may be dispersed in the fluoropolymer in any suitable manner, but in preferred embodiments, the inorganic particulate filler is uniformly dispersed throughout the fluoropolymer layer, coating or body, and in a particularly preferred embodiment, is also present on the surface of the fluoropolymer outer layer. In a preferred embodiment, the inorganic particulate filler is dispersed or disposed in the proximal working surface of the fuser member as desired to provide the filler at or near the surface for interaction with the functional release agent. Preferred fillers include a metal-containing filler, such as a metal, metal alloy, metal oxide, metal salt or other metal compound. The general classes of metals which are applicable to the present invention include those metals of Groups 1b, 2a, 2b, 3a, 3b, 4a, 4b, 5a, 5b, 6b, 7b, 8 and the rare earth elements of the Periodic Table. Preferably, the filler is an oxide of aluminum, copper, tin, zinc, lead, iron, platinum, gold, silver, antimony, bismuth, zinc, iridium, ruthenium, tungsten, manganese, cadmium, mercury, vanadium, chromium, magnesium, nickel and alloys thereof. The particularly preferred inorganic particulate fillers are aluminum oxide and cupric oxide. Preferred fillers also include reinforcing and non-reinforcing calcined alumina and tabular alumina respectively.

The inorganic particulate filler may be present in the polymer in an amount sufficient to interact with the hydride release agent having functional groups. This generally comprises an amount from about 15 to about 25 volume percent, preferably from about 19 to about 22 based upon the volume of the polymer in the outer layer of the fuser member.

The particle size of the filler dispersed in the polymer is from about 1 to about 9 micrometers, preferably from about 1 to about 3 micrometers.

The inorganic particulate filler may possess irregular shapes, however, any form of inorganic particulate may be used in the fusing surface like powders, platelets, spheroids, fibers, oval particles, and the like. The base support member may be selected from any suitable material.

Other adjuvants and fillers may be incorporated in the fluoropolymer outer layer in accordance with the present invention as long as they do not effect the integrity of the fluoropolymer or the interaction between the optional inorganic particulate filler material and the hydride release agent having functional groups. Such fillers normally encountered in the compounding of fluoropolymers include coloring agents, reinforcing fillers, cross-linking agents, processing aids and accelerators.

The outer layer of the fuser member is preferably prepared by mixing a solvent such as methyl ethyl ketone, methyl isobutyl ketone and the like with a fluoropolymer compound containing the desired type(s) and amount(s) of inorganic filler particles and curative agents along with steel shot for mixing. The mixture is stirred to allow the filler and optional additive(s) to become wet from the solvent (approximately 1 minute). Next, an amount of polymer, preferably a fluoropolymer, is added and the contents are mixed (approximately 20-40 minutes, and preferably 30 minutes). A curative and stabilizer (for example, methanol) are then added and mixed again (approximately 15 minutes). The final solid content of the dispersion is from about 10 to about 25 percent and preferably from about 16 to about 22 percent by weight. The steel shot is filtered, the dispersion collected and then coated onto the substrate. The coated layers are first air-dried (approximately 2-5 hours) and then step heat cured in a programmable oven (65°C for 4 hours, 93°C for 2 hours, 144°C for 2 hours, 177°C for 2 hours, 204°C for 2 hours and 232°C for 16 hours).

The outer surface is deposited on the substrate via well known processes including applying the fluoropolymer optionally containing the inorganic filler particles therein to the substrate either by one application or by successive applications of a thin coating or coatings of the outer layer. Coating is conveniently carried out by flow coating, dipping or spraying such as by multiple spray applications of very thin films, web deposition, powder coating or the like can also be used. If successive applications of coatings are used, it may be necessary to heat the fluoropolymer layer after each successive application in order to remove the solvent. The layer can be heated to from about 25 to about 50°C or higher so as to flash off most of the solvent contained in the outer layer.

The thickness of the outer fluoropolymer surface layer of the fuser member herein is from about 25 to about 250 micrometers, preferably from about 50 to about 200 micrometers.

Optional intermediate adhesive layers and/or intermediate polymer or elastomer layers may be applied to achieve desired properties and performance objectives of the present invention. The intermediate layer may be present between the substrate and the outer polymer surface. An adhesive intermediate layer may be selected from, for example, epoxy resins and polysiloxanes. Preferred adhesives are proprietary materials such as THIXON 403/404, Union Carbide A-1100, Dow TACTIX 740, Dow TACTIX 741, and Dow TACTIX 742. A particularly preferred curative for the aforementioned Dow TACTIX 741 and 742 adhesives is Dow H41. Intermediate polymer layers may be selected from the fluoropolymers listed above, as well as any suitable silicone rubbers.

There may be provided an adhesive layer between the substrate and the intermediate layer. There may also be an adhesive layer between the intermediate layer and the outer layer. In the absence of an intermediate layer, the polymer outer layer may be bonded to the substrate via an adhesive layer.

The thickness of the intermediate layer is from about 0.5 to about 20 mm, preferably from about 1 to about 5 mm.

The release agents or fusing oils described herein are provided onto the outer layer of the fuser member via a delivery mechanism such as a delivery roll. The delivery roll is partially immersed in a sump which houses the fuser

oil or release agent. The hydride release agent or hydride oil is renewable in that the release oil is housed in a holding sump and provided to the fuser roll when needed, optionally by way of a release agent donor roll in an amount of from about 0.1 to about 10 mg/copy, and preferably from about 1 to about 8 mg/copy, or in an amount of from about 0.1 to about 4 micrometers thick, preferably from about 0.1 to about 2.5 micrometers. The system by which fuser oil is provided to the fuser roll via a holding sump and optional donor roll is well known. The release oil may be present on the fuser member in a continuous or semicontinuous phase. The fuser oil in the form of a film is in a continuous phase and continuously covers the fuser member.

Any silicone hydride oil having functional groups that interact with the fillers on the outer surface of the fuser member so as to lower the surface energy thereof may be used. It is preferred that the silicone hydride oil function so as to absorb into the cellulose fibers of the paper, while retaining the functionality. Such a suitable functional silicone hydride oil may be used in combination with a non-functional release agent. Specific examples of functional silicone hydride oils selected for the present application include poly(methyl hydrosiloxanes) and in embodiments, poly(methyl hydrosiloxanes) with pendent or terminal hydride groups. Preferred examples include those having pendant hydride groups such as those available from Hüls of America such as, for example, Huls PS 123.8 a poly(methyl hydrosiloxane) having 0.75 weight % pendant hydride groups; and PS 124.5 [poly(methyl hydrosiloxane) having 3.5 weight % pendant hydride groups]; and the like. Examples of hydride terminated functional silicone oils available from Hüls of America are PS 542, a  $5 \times 10^{-4} \text{ m}^2/\text{s}$  (500 cs) polydimethylsiloxane oil with a terminal hydride group content of 0.8 weight percent; and PS 543, a  $1 \times 10^{-3} \text{ m}^2/\text{s}$  (1000 cs) polydimethylsiloxane oil with a terminal hydride group content of 0.5 weight percent. The hydride content of the silicone hydride release oil of the present invention is from about 0.1 to about 5.0 weight percent, and preferably from about 0.5 to about 3.5 weight percent. These hydride functional oils can be selected as supplied, or they can be diluted with nonfunctional release oils commercially available, such as nonfunctional polydimethylsiloxanes from  $1 \times 10^4 \text{ m}^2/\text{s}$  to  $2 \times 10^{-2} \text{ m}^2/\text{s}$  (100 cs to 20,000 cs). Standard, nonfunctional silicone oils of various viscosities are available from the well known silicone material suppliers such as the DC200 fluids from Dow Corning Silicones of Midland, MI; the SF96 fluids from G. E. Silicones of Waterford, NY and the SWS 101 fluids from Wacker Silicones of Adrian, MI.

When the functional hydride silicone oil is used in combination with a non-functional silicone oil, the amount of functional hydride oil is from about 0.5 to about 99.5, and preferably from about 15 to about 85 weight percent of the non-functional silicone oil. The concentration of the aforementioned diluted non-functional oil is, for example, from about 0.5 to about 99.5, preferably from about 15 to about 85 weight percent of the functional hydride oil. One preferred composition of non-functional and functional oil is comprised of 15 weight percent of PS 124.5 and 85 weight percent of a nonfunctional oil. Molecular weights, gram/mole, and viscosity in  $\text{m}^2/\text{s}$  (centistokes), for the functional hydride oil can be, for example, from about 5,000 to about 30,000 and from about  $1 \times 10^{-4}$  to about  $1 \times 10^{-3} \text{ m}^2/\text{s}$  (100 to about 1,000 centistokes), respectively, while for the nonfunctional oils the corresponding values can be from about 5,000 to about 80,000, and from about  $1 \times 10^{-4}$  to about  $2 \times 10^{-2} \text{ m}^2/\text{s}$  (100 to about 20,000 centistokes), respectively.

A nonfunctional oil as used herein refers to oils which do not chemically react with the fillers on the surface of the fuser member. A functional oil as used herein refers to a release agent having functional groups which chemically react with the fillers present on the surface of the fuser member so as to reduce the surface energy of the fillers so as to provide better release of toner particles from the surface of the fuser member. If the surface energy of the fillers is not reduced, the toner particles will tend to adhere to the filler particles on the surface of the fuser oil, which will result in copy quality defects.

Catalysts may be used herein; however, it is not necessary to add catalysts in the present invention. Catalysts can be used for effective hydrosilation reaction. Examples of suitable catalysts include chloroplatinic acid or other complexes of the noble metals such as palladium, rhodium or ruthenium. These catalysts are normally added on the basis of from about 5 to about 10 parts of platinum, palladium, rhodium or ruthenium per million of the hydride oil.

Although the mechanism of reaction of hydride functional oil with the polymer is not known, it is theorized that in embodiments, the hydride oil reacts with the hydroxy groups on the filler such as calcined alumina through hydrogen bonding and with the unsaturation sites on the polymer. The release agent has a higher affinity for the fillers on the surface of the fuser member than for the toner. The release coating has a cohesive force which is less than the adhesive forces between heated toner and the substrate to which it is applied and the cohesive forces of the toner. The release layer forms a barrier between the toner and the fuser member and helps to prevent toner from adhering to the surface of the fuser member. This results in a reduction in toner offset and an extension of the fuser release life. Also, in embodiments, the hydride functional oil is able to be absorbed into the copy sheet paper (cellulose fibers) and does not remain present on the surface of the copy sheet. In this manner, inks, glues and adhesives can readily attach to the copy sheet because there is minimal or no oil remaining on the surface of the copy sheet.

This plausible mechanism of reaction is in contrast to the mechanism of reaction by use of amino silicone oil. By use of amino silicone oil, the oil remains on the surface of the copy sheet, possibly by a hydrolysis reaction of the amino groups with the cellulose rings on the surface of the paper. The result is that inks, glues and adhesives cannot attach to the copy sheet due to the amino silicone oil remaining on the surface.

The following Examples further define and describe embodiments of the present invention. Unless otherwise indicated, all parts and percentages are by weight.

## EXAMPLES

### Example I

A poly(methyl hydrosiloxane) oil PS 124.5 obtained from Huls of America and containing 3.5 wt % hydride groups without added catalyst was used as the fuser oil release agent in a Xerox Corporation 4635MX copy machine. The fuser oil was added to the fuser oil sump and a layer of fuser oil coating of from about 1 to 8 mg/copy was applied to the fuser member. The fuser roll coating in the Xerox 4635MX copy machine was comprised of VITON GF filled with 20 volume percent calcined alumina which was prepared using known methods and more specifically, in accordance with the procedure outlined above.

One hundred preprinted bank personal checks were copied in the above Xerox 4635MX copy machine using the poly(methyl hydrosiloxane) oil as set forth above. The checks were then cut to standard size and presented through an amount encoder machine in order to print a series of inks on the checks showing the amount of the check. The checks were then placed in a standard golden qualifier machine in order to determine signal strength. The signal strength is a measure of the amount of ink remaining on the bank check. This test was performed primarily to determine how well the ink adhered to the bank checks which were previously subjected to a hydride fuser oil in accordance with the present invention.

As shown in Table 1 below, printing tests showed that the signal strength of the hydride oil is high and approaches that of plain paper. This is not the case for some of the comparative amino oils as shown below. The signal strength is a measure of the amount of ink remaining on the paper (bank check in this case). Therefore, the tests showed that the hydride oil of the present invention did not interfere with the adherence of ink to the bank checks, rather, the bank checks mimicked that of plain paper.

Table 1

| Signal Strength  |                         |
|--|-------------------------|
| Type of release agent  | Average signal strength |
| no agent, plain paper  | 109                     |
| monoamino oil (Dow Corning, $\gamma$ -aminopropyl substituted polydimethylsiloxane having an amine content of about 0.06 mol%)                 | 95                      |
| mercapto oil (Wacker, $\gamma$ -sulfhydrylpropyl substituted polydi- methylsiloxane having a sulfhydryl content of about 0.20 mol%)            | 95                      |
| Fuser Shield (Wacker, $\gamma$ -aminopropyl substituted polydimethylsiloxane having an amine content of about 0.06 mol%)                       | 52                      |
| hydride oil (Huls of America - (Huls of America PS 124.5 hydrogen substituted polydimethylsiloxane having a hydride content of about 3.5 mol%) | 99                      |

The results shown in Table I above demonstrate that the signal strength with the hydride oil of the present invention is higher than other oils tested. In addition, the signal strength of the hydride oil mimics that of plain paper. These results show that the hydride oil with the present invention has a relatively low adherence to the paper surface, thus providing excellent qualities for post printing applications.

### Example II

Experiments indicated that there was a specific interaction between the paper cellulose fibers and the amine in monoamino silicone oil but not with the hydride functional group in hydride silicone oils. One half gram of each of a monoamino oil (Dow Corning,  $\gamma$ -aminopropyl substituted polydimethylsiloxane having an amine content of 0.60 mole percent) and a hydride silicone oil (Huls of America PS 124.5 hydrogen substituted polydimethylsiloxane having a hydride content of 3.5 percent) was diluted with 4.5 grams of hexane and the resulting mixture was passed through 12 pipettes packed with a total of 6.7 grams of cotton cellulose. The solutions passed slowly through the columns only under the influence of gravity. The collected filtrates were dried with a stream of nitrogen. The amine functionalized

fluid initially contained 0.60 mole percent amine groups, but after filtration, this amount was reduced by a third to 0.40 percent, as measured by Nuclear Magnetic Resonance Spectroscopy. On the other hand, the hydride group concentration, which was initially 3.5 percent, was nearly unchanged at 3.4 percent in the filtrate.

The results show a significant reduction in amine content filtering through the cellulose bed. This demonstrates that there was a significant adsorption of amine groups to the cellulose fibers. In contrast, when the hydride silicone oil was passed through the cellulose bed, there was a negligible reduction in hydride content measured. This data show that, unlike the monoamino fluid, the hydride silicone oil does not absorb into the paper cellulose fibers and cannot diffuse into the paper. The result is good surface adhesion of check endorser inks and attachable notes such as Post-It® Notes.

## Claims

### 1. A fuser member (1) comprising:

- a) a substrate (4);
- b) an outer layer (2) on said substrate (4), said outer layer (2) comprising a fluoropolymer; and thereover
- c) a hydride release component comprising a silicone hydride release oil.

### 2. A fuser member in accordance with claim 1, wherein said fluoropolymer is selected from the group consisting of polytetrafluoroethylene, fluorinated ethylenepropylene copolymer and polyfluoroalkoxypolytetrafluoroethylene.

### 3. A fuser member in accordance with claim 1, wherein said fluoropolymer is a fluoroelastomer selected from the group consisting of a) copolymers of vinylidene fluoride and hexafluoropropylene; b) terpolymers of vinylidene fluoride, hexafluoropropylene and tetrafluoroethylene; and c) tetrapolymers of vinylidene fluoride, hexafluoropropylene, tetrafluoroethylene and a cure site monomer.

### 4. A fuser member in accordance with any of claims 1 to 3, wherein said outer layer (2) further comprises an inorganic particulate filler dispersed in said polymer and being present on the surface of said outer polymer layer.

### 5. A fuser member in accordance with claim 4, wherein said filler is selected from the group consisting of aluminum oxide and cupric oxide

### 6. A fuser member in accordance with any of claims 1 to 5, wherein said silicone hydride release oil has a hydride content of from about 0.1 to about 5.0 weight percent.

### 7. A fuser member in accordance with any of claims 1 to 6, wherein said silicone hydride release oil is a poly(methyl hydrosiloxane).

### 8. A fuser member in accordance with claim 7, wherein said silicone hydride release oil comprises pendant hydride groups.

### 9. An image forming apparatus for forming images on a recording medium comprising:

- a) a charge-retentive surface to receive an electrostatic latent image thereon;
- b) a development component to apply toner to said charge-retentive surface to develop said electrostatic latent image to form a developed image on said charge retentive surface;
- c) a transfer component to transfer the developed image from said charge retentive surface to a copy substrate; and
- d) a fuser member in accordance with any of claims 1 to 8.

### 10. An electrophotographic process comprising:

- a) forming an electrostatic latent image on charge-retentive surface;
- b) applying toner to said latent image to form a developed image on said charge retentive surface;
- c) transferring the toner image from said charge-retentive surface to a copy substrate;
- d) fixing said toner image to said copy substrate by passing said copy substrate containing said toner image in between a pressure member (8) and a fuser member in accordance with any of claims 1 to 8.



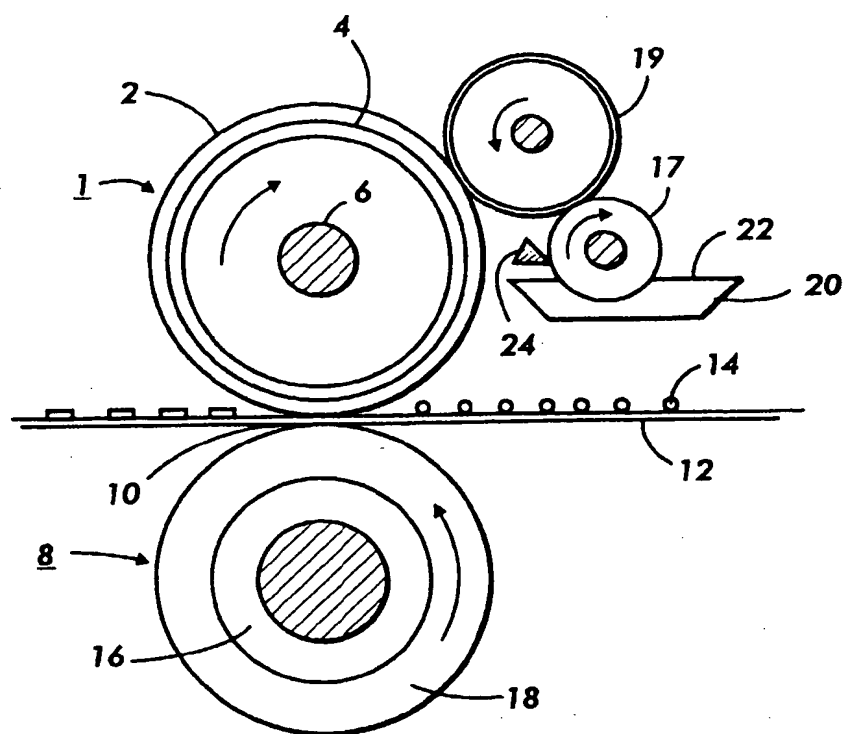
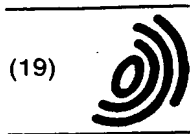


FIG. 1

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(11)

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(12)

## EUROPEAN PATENT APPLICATION

(88) Date of publication A3:  
28.04.1999 Bulletin 1999/17

(51) Int Cl.<sup>6</sup>: G03G 15/20

(43) Date of publication A2:  
06.05.1998 Bulletin 1998/19

(21) Application number: 97308833.9

(22) Date of filing: 04.11.1997

(84) Designated Contracting States:  
AT BE CH DE DK ES FI FR GB GR IE IT LI LU MC  
NL PT SE

(30) Priority: 05.11.1996 US 744031

(71) Applicant: XEROX CORPORATION  
Rochester, New York 14644 (US)

(72) Inventors:  
• Badesha, Santokh, S.  
Pittsford, NY 14534 (US)  
• Pan, David H.  
Rochester, NY 14625 (US)  
• Kaplan, Samuel  
Walworth, NY 14568 (US)  
• Eddy, Clifford O.  
Penfield NY 14580 (US)

- Henry, Arnold W.  
Pittsford, NY 14534 (US)
- Heeks, George J.  
Rochester, NY 14617 (US)
- Chow, Che C.  
Penfield, NY 14526 (US)
- Fratangelo, Louis D.  
Fairport, NY 14450 (US)
- Fraser, David J.J.  
Webster, NY 14580 (US)
- Hanzlik, Edward C.  
Fairport, NY 14450 (US)

(74) Representative: Pike, Christopher Gerard et al  
Rank Xerox Ltd.,  
Patent Department,  
Parkway  
Marlow, Buckinghamshire SL7 1YL (GB)

### (54) Coated fuser member

(57) A fuser member having a fuser member release agent for use in an electrophotographic apparatus for enhancing toner release from a fuser member, the fuser member comprising a substrate (4), an outer fluoropolymer layer (2) optionally comprising a conductive filler, and a silicone hydride release oil component thereover.

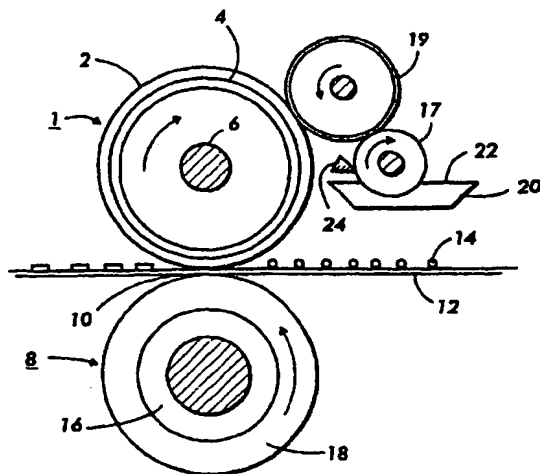


FIG. 1

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# EUROPEAN SEARCH REPORT

Application Number  
EP 97 30 8833

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| Place of search<br><b>THE HAGUE</b>   |  | Date of completion of the search<br><b>9 March 1999</b> | Examiner<br><b>Lipp, G</b>                              |
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09-03-1999

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